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# DEFENCE

OF THE

# DOCTRINE OF VITAL AFFINITY.

BY

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## XXIV.—*Defence of the Doctrine of Vital Affinity.* By William Pulteney Alison, M.D., &c. &c., Professor of the Practice of Medicine in the University of Edinburgh.

(Read 15th March 1852.)

Having expressed a decided opinion that there are, in all living bodies, chemical as well as mechanical phenomena, which, in the present state of our knowledge, ought to be designated as Vital, and referred to the operation of laws, distinct from those that regulate the chemical changes of inanimate matter, and observing that this opinion is controverted, and that the view of the chemical phenomena of life which I have maintained, is rejected as unphilosophical and delusive by two authors of high scientific reputation—Baron Humboldt and Dr Daubeny,—and that the judgment of other authors of acknowledged character on this subject is not clearly expressed, and seems to me to involve it in unnecessary obscurity, I am led to hope that some farther explanations may be of some use in establishing the first principles of a Science which, as it appears to me, has suffered, in several instances, not so much from want of facts, as from hypothetical and erroneous inferences, drawn from facts that are already known.

When I first undertook, above thirty years ago, to deliver lectures on Physiology, I ventured to express an opinion, that "a discovery would be made, connecting the *ingesta* into the animal body with the nourishment of the different textures, and with the nature of the different *excretions*, equally important as illustrating the obscure *chemical phenomena* of the living body, and the intention of the different secretions, as the discovery of the circulation of the blood was, in illustrating the *movements* going on in its interior, and the use of the organs concerned in effecting them." It did not occur to me, nor do I know that any one had then conjectured, that these chemical phenomena, like the movements of the animal fluids, partook of the nature and formed part of *a circulation*, but of one of such extent and complexity, that the atmosphere, the soil, and the vegetable kingdom, furnish the other great links in the circuit, and that all the elements of the ancients, fire, air, earth, and water, are literally and essentially concerned as agents in maintaining it.

It appears, however, from the following passage in one of the earlier writings of Sir Humphry Davy, that he was aware of, and had duly reflected on, the most material facts on which this important discovery is founded:—"Nature has catenated together organic beings, and made them mutually dependent on each other for their existence, and all dependent on light. A privation of light would be immediately destructive to organic existence; vegetation would cease; the supply of oxygen gas would be quickly cut off from animals; the lower strata of the atmosphere would become composed of carbonic acid; and perception and volition would exist no longer."*

The following description of the circulation, in which all the matter destined by Nature to the maintenance of organised creation on the earth's surface is continually engaged, is merely an amplification of the expressions of DUMAS; and although part of the statements contained in it are liable to objection, its general import is such as amply to fulfil the expectation of a great discovery which I had expressed.

Vegetables, under the influence of light and of a certain temperature, are continually abstracting from the atmosphere, directly or indirectly, a part of its constituents, in the form of water, carbonic acid, a little nitric acid, and ammonia. The radicals of this inorganic matter (*matiere brute*) are gradually organised in vegetables, which are a true reducing apparatus, while a part of its oxygen is set free; and, after being formed into organic principles, those radicals are yielded directly or indirectly to animals. This matter is applied, without farther change, to the maintenance of the functions of animal life; particularly it furnishes the conditions, and becomes the instrument, of mental acts; after which, as if exhausted by the effort which it has made, it falls again under the influence of oxygen, in the animal body, which is a true apparatus of combustion; and either before or after the death of the animal structure, returns as inorganic matter, under the name of manure, to the great reservoir from which it came. In this eternal circuit, life is the chief agent, and by these changes it makes itself known; but the matter that is thus employed undergoes only a change of place. I apprehend we must add, that the *properties* as well as the *position* of this matter are continually *altered* and *resumed*, and that it is the modification which the properties of this matter undergo, in the course of this circulation, which constitutes the precise object of all physical inquiries, both in vegetable and animal physiology, so far as the organic functions of animals are concerned.

The final cause of all these changes is already obvious. We know that it has pleased the Author of our being to connect with a world previously existing, and consisting of matter already long endowed with all its physical properties, an infinite number and variety, and eternal succession, of sensitive creatures, and ultimately a race of beings "formed after his own image." The acts of sensation and thought which characterise these, he has placed in immediate connection with that peculiar structure, endowed with still more peculiar properties, to which we give the name of a living Nervous System; and he has established laws, in the execution of which the vegetable as well as the animal kingdom bears its part, according to which infinite varieties and endless successions of nervous systems shall be engendered and supported from a limited quantity of the matter originally contained in the atmosphere surrounding our globe,—shall be nourished, lodged, protected, and enabled to satisfy the wants and to obey the will of their immaterial inhabitants; but all this innovation on the laws regulating the matter previously existing on the earth's surface is only transient. The same portions of matter which are thus employed, whether they pass through vegetable structures only, or minister to the support both of vegetables and animals, are restored unchanged to the reservoir whence they came,—in the latter case more rapidly and frequently, and during the life of the structures thus maintained,—and are ready to run the same course again when again placed in presence of living beings. Like the figures of snow into which the imagination of SOUTHEY figured the magician OKBA, breathing the breath of life every morning, that they might people the surrounding wilderness, and charm the solitude of his daughter LEILA, they all receive vitality only for their day, and

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* Works, vol. i., p. 106.

> " Ever when night closes,
> They melt away again ;"

and such of them as have served as the habitations of mental acts or feelings then " restore the spirit to Him who gave it." The provisions for the temporary maintenance, for the protection and comfort, for the sentient and mental enjoyments, and the eternal reproduction, of this infinite number and variety of sensitive beings, out of a limited quantity of certain chemical elements contained in the earth's atmosphere,—and for the progressive development of the human mind, as the destined lord of this Creation,—are the great Laws of Life, the investigation of which is the object of this science. The power of perceiving their adaptation to their object, and of appreciating the grandeur of the design, is one of the highest privileges of our nature; and without pretending to be qualified to assign the respective merit of the different physiologists, geologists, and chemists, who have illustrated the different parts of this general view of life,—of CUVIER, DALTON, PROUT, LIEBIG, BRONGNIART, PREVOST, DUMAS, and BOUSINGAULT, and their numerous friends and followers,—we may all congratulate ourselves on having lived in the age when so much of the designs of Infinite Wisdom for the regulation of this world has been made manifest to mankind.

But when we inquire a little more minutely into the nature of the changes constituting this great vital circulation, I think it must appear obvious, that the most essential of all are and must be strictly *chemical;* and it seems to me that the grandeur of the design is not clearly perceived, unless we fix attention on the alteration *of all* the qualities of matter which are here implied, and shew that the Power which has introduced living beings upon earth has had at its command, and has actually modified, *all the laws of nature.* The water, carbonic acid, and ammonia, which form the chief and essential constituents of the ingesta of vegetables, are there thrown into combinations, differing from any which they form, or which can be formed from the elements composing them, in any other circumstances. This is fairly admitted by Dr Daubeny, who says,—" We are still far from imitating Nature in those processes by which she continues to bring about the wonderful products of organic life, and must admit that, judging from what is yet known, there would seem to be *a power residing in living matter*, *distinct*, at least in its effects, *from ordinary chemical and physical forces.*[*]

Now, before going farther, let us observe how essential to everything living, and how peculiar in its effects (from which alone it is known to us), is this power residing in living matter, and distinct from ordinary chemical forces, but which Dr Daubeny must regard as producing chemical effects, because he himself ascribes to it the formation of " the wonderful products of organic life."

Let us remember, that the very first requisite to the commencement of this great vital circulation, the decomposition of the carbonic acid of the atmosphere, fixing the carbon which is to serve as the basis of all organised structures, and setting free the oxygen, producing therefore a change which is unquestionably both peculiar and chemical, "is done by a power," as stated by Liebig, " surpassing that of the strongest galvanic battery, to which the strongest chemical action cannot be compared." Next, let us observe, that the compounds formed in living bodies under the influence of this acknowledged power, of which the first indications are so striking, possess peculiarities (which I formerly noticed) quite sufficient to distinguish them from all compounds formed by chemical affinities, under any other circumstances in nature. They have a uniform complexity of constitution, even in the minutest particles, not seen in inorganic solids; they assume perfectly definite forms, varying, not according to their chemical constitution, but according to their living progenitors, or the particles of living matter with which they come in contact. These forms, as long as they belong to living structures, never become crystalline; although the same elements, after escaping from the immediate contact and influence of living structures, even within the excretory ducts by which they are to be thrown out of the body, fall into compounds which take the crystalline arrangement. Above all, these organic compounds, thus influenced by *place,* are equally liable to an influence of *time.* They are all of transient duration, and particularly in the case of animals, we know that at the same time, at the same points, and in presence of the same agents, in which the matter originally introduced from vegetables is applied to the nutritive assimilation and formation of the living textures, other portions of the same elements, previously used in the same process, are continually yielding to the influence, previously resisted, of the oxygen of the air, and are forming another set of compounds, by the process of destructive assimilation, which are ready to take the form of crystals; which either already possess, or rapidly tend to, the composition of the inorganic matter whence all these compounds originate;—which are poisonous if retained in the body, and for which, therefore, outlets are provided in the organs of excretion, so as to justify the striking expression of CUVIER, that all living animal matter, although the depository of force which will compel other matter to follow the same course as itself, will soon occupy its own place no longer. This is a series of chemical changes quite distinct from anything seen in any other circumstances of Nature. And farther, we know, in regard to the power exciting these, that it is obedient to certain laws of animal life, to which nothing analogous is seen in other chemical operations; nutrition and secretion being liable to sudden and important change, as living movements are, by living changes in nervous matter, *e. g.*, by those which attend certain acts of mind; and farther, every such action being liable to diminution or exhaustion by the degree in which it is itself exercised.

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[*] On the Atomic Theory, p. 370.

It will be observed, that all these are peculiarities in the *chemical* nature and constitution, even of the minutest particles of all living structures; and that without reference to them nothing living can be characterised. These phenomena are just as distinctly peculiar to living bodies, and characteristic of their living state, as the contraction of muscles, whether produced by irritations of their own fibres or of the nerves entering them; and they are much more general in all classes of living beings. If anything in the economy of living beings demands explanation, or is deserving of being made the object of scientific research, it must be these, their most essential characteristics. If they are not of such importance as to demand special investigation,—if it is only the movements of the particles concerned either in the development of vegetables, or the varied functions of animals, that we ought to regard as peculiar to living bodies,—then Physiology, so far as these properties of living bodies are concerned, has no claim to the title of a separate science, it is only a branch of Chemistry. But it is just as probable, *a priori*, that the laws of chemistry should undergo a modification in living bodies, as that the laws of motion should be made subordinate in certain parts of living animals, to the vital property of Irritability of muscles, as explained by HALLER; and the very peculiar changes which are observed in tracing the course of the elements of water, carbonic acid, and ammonia, which are absorbed by vegetables, until they pass out in the form of water, carbonic acid, and ammonia (or in compounds immediately resolvable into them), in the excretions of animals, and resume their office as manures, afford a manifest presumption that such modification takes place.

The chief consideration which seems to have prevented Dr Daubeny from acknowledging that the power which he himself supposes to exist in living beings, and to regulate chemical changes there, is deserving of a separate name and a separate inquiry, is thus stated:—"If it is asserted that this power is to be directly ascribed to the vital principle itself, we pause for further information."

Here it seems to me manifest, that there is a misapprehension as to the correct meaning of words, and one which may be traced in many other speculations in the elementary departments of physiology,—investing the term Vital Principle with a meaning much more mysterious and formidable than is needful. According to the only idea which I can form of what is properly termed the vital principle, Dr Daubeny has already admitted, in the words above quoted from him, that, so far as we can yet see, we *must* regard the vital principle as concerned in forming the "wonderful products of organic life;" because he says, that these result from a power residing in living matter, producing physical effects, yet distinct in its effects from ordinary chemical and physical forces.

The only correct way of defining what we call Vitality, or the vital principle, as I have always maintained, and as I think the best authorities now admit, is this:—First, we describe what we call living beings. They are those, as Cuvier states, which originate by a process of generation, which we can describe,—are maintained by a process of growth and nutrition, which we can describe,—and terminate by death and decomposition, which we can describe. Then, having thus discriminated those bodies which we call living, we say that, in so far as we can satisfy ourselves, that any part of the phenomena which they present are inexplicable by, and inconsistent with, the laws regulating the changes of any other matter, we call them effects of the vital principle, or vitality; and that is our definition of those terms. Those who object to the use of the substantive noun Vitality, or the Vital Principle, as a general expression for such phenomena, constantly use the adjective Vital, or Living, which conveys the very same meaning, and can be defined, as I apprehend, in no other way. The real *efficient* cause of these, as of all other phenomena in nature, is the Divine Will, and is inscrutable; but we know, that in all departments of Nature, this all-powerful cause acts according to laws which we can understand, and the discovery and application of which is the object of all science. When we see that any phenomena in nature take place according to the same law as others more familiar, we are said to explain them, or to assign their physical cause; but until that is clearly ascertained, we obey the dictates of science in declining to arrange them along with those depending on any law otherwise known to us, and endeavouring to apply the method of induction to themselves,—and to any such isolated phenomena as may seem analogous to them,—so as to ascertain laws peculiar to this set of phenomena.

Dr Daubeny refers also to a passage in the writings of Dr Bostock, in which he speaks of reference to the operation of the vital principle, or to any vital affinities, "as one of those delusive attempts to substitute words for ideas, which have so much tended to retard physiological science;" or, as it may be more simply expressed, as only a reference to an occult cause, or a confession of ignorance on the subject. On this I would observe, that if, by merely using the term Vital Affinity, we were to suppose that we offered a *sufficient explanation* of any phenomena, I would agree with Dr Bostock. But I use the term only as defining the department of human knowledge to which these phenomena are to be referred, and in which the explanation of them (*i. e.*, the law according to which they take place), is to be found; and thus using it, I maintain that there is nothing delusive or unscientific in thus limiting and fixing the object of our inquiries. The investigation of the law or laws by which vital affinities are distinguished from the affinities of inorganic matter, is a subsequent inquiry, in which we may add, that some progress has been made. It is something, for example, to say that vital affinities shew themselves in living beings in two distinct ways; *first*, by the formation of new compounds, found nowhere else in nature; *secondly*, by the selection and attraction of these compounds, at different points, out of a very complex fluid, so as to form organised structures; and to point out the circumstances in which these powers act. It is something to say, with Dr Prout (if that principle is to be held as established), that in the formation of new compounds in living bodies, the elements employed by nature are not subjected to any new affinities, but only hindered from obeying certain of those which actuate them in other circumstances; while others are allowed to act. It is something to say, that the compounds thus formed perish many times during the life of the structure in which they are contained,—the more rapidly as their vital properties have been more energetically exercised; and by perishing furnish the poisonous matter which continually circulates in every living animal, and for the expulsion of which the organs of excretion are provided. It is something to say that Carbon, fixed from the atmosphere by plants, is the substratum of all the organic compounds of which living beings are composed; and that Oxygen, taken in by the lungs or gills of animals, is the great agent in forming the excretions by which they are constantly worn down. And I think we define and limit all these inquiries satisfactorily, when we say, that we seek to ascertain the laws, according to which ordinary chemical affinities are modified in living bodies; or according to which that power acts, which, by Dr Daubeny's own admission, resides in living bodies, and produces chemical effects, "but is distinct from ordinary chemical forces."

Dr Daubeny goes on to say, that Nature has at her command an apparatus of a more refined and subtle description than any which we can command, and may therefore accomplish effects by purely chemical and physical agency, which may for ever lie beyond the reach of the coarser manipulations of art; and here he refers to HUMBOLDT, who says, that, as we do not understand all the conditions under which ordinary chemical and physical forces act in living beings, we are not entitled to *assert* that they *may not* produce all the chemical changes that we see in them: to what conditions he here alludes does not appear, but he gives this as a reason for renouncing, or, at least, expressing doubts as to the theory of vital affinity, which he had formerly espoused, and illustrated by an allegory under the name of the Rhodian Genius.

Dr DAUBENY says more precisely, that "the peculiar *structure of parts*, arising out of the *Movements* induced by a vital principle, *may be found* competent to bring about these phenomena in question, and that it is incumbent on us to investigate to the full the extent to which such physical causes can be supposed to operate, before pronouncing whether there may not, after all, be some *residual phenomenon*, inexplicable by the common principles of science, and which we must, therefore, refer to vital affinity." But even in regard to movements, from his expressions at p. 379, he does not seem to admit that any others are to be ascribed to the vital principle, than those which result from Contractility.

In thus admitting that the *movements* which take place in living animals, at least those which can be referred to contraction of solids, arise out of the vital principle (which, I apprehend, means only that they are an ultimate fact,—so far as yet known exemplified in no other department of nature); and in ascribing to the peculiarity of those movements the peculiar structure of living parts, and through the intervention of that structure the peculiar chemical changes of living beings, Dr DAUBENY has stated what I believe to be the general idea of those physiologists who reject the doctrine of vital affinity. They think that having allowed that *movements*, and particularly contractions of living solids, are truly vital phenomena, they have furnished a *possible* explanation of all chemical changes which seem peculiar to life, and that they are entitled to throw on us the burden of *disproving this theory*, before they can be called on to admit any such principle as vital affinity modifying chemical laws in the living body.

To this I reply, *first*, that this theory in explanation of the chemical phenomena of life is distinctly *inadequate*. I do not think it can be more distinctly stated, or more plausibly supported, than it was by the late Dr MURRAY, in treating of *Secretion*, who, at the same time, however, distinctly admitted that it was "*hypothesis* supported by little direct proof. The cause of production of the new combinations which constitute secretion," he says, "*may be* the simple approximation of the elements which constitute the blood. That fluid is propelled byt he vis a tergo into canals of the most astonishing minuteness, the diameters of which are still farther diminished from their alternate contraction from the stimulus of the blood. There can be no doubt that in compounds the force of attraction subsisting among their constituent particles, is modified by the distance at which these are placed; and in compounds especially, which consist of four or more principles, the slightest alteration in their relative situation is sufficient to change entirely their existing attraction, and induce new combinations. The blood is a compound of this kind; its ultimate principles, too, are capable of entering into an innumerable variety of combinations with each other; we may conceive, therefore, that when subjected to the contraction of the extremely minute vessels through which it is forced to circulate, the relative position of its elements will be changed, and new combinations formed. And if we suppose a fluid thus passing through tubes of different diameters, and undergoing successive decompositions, we may easily conceive that very different products may be formed from the same original compound. This affords a very simple view of the nature of Secretion. No complicated apparatus is requisite; all that is necessary being the propulsion of the blood through extremely minute vessels capable of contraction. And it is easy to account for the variations to which secretion is liable, as the contraction of the vessels must vary from variations in the state of their irritability and of the stimuli acting on them." [*Murray's System of Chemistry*, vol. iv., p. 518.] In regard to the Nutrition of solids, Dr MURRAY says merely that they appear to *attract immediately from the blood* the materials which it contains ready formed, as there is probably "no solid in the animal body, of which the immediate principles do not exist in the blood." [*Ibid.*, p. 516.] But I need hardly say that subsequent researches have not only completely demonstrated the insufficiency of this explanation, but have shewn that the cause of the difference of products formed apparently from the same blood must be essentially different from that here assigned; and I would say farther, have shewn that the peculiarity of the compounds formed in living bodies cannot be reasonably ascribed to any modification of those *movements* of fluids, which Dr DAUBENY regards as the only results of the vital principle. To shew this, I need not go into the question of the mode of action of arteries on the blood, or the portion of the changes essential to secretion, which takes place in *cells*, exterior to vessels, and, of course, cannot be ascribed merely to the pressure to which the blood passing along the vessels may have been subjected; which had certainly been misapprehended by MURRAY, as by most other physiologists of that day. It is sufficient to quote a brief statement from CUVIER, which seems to me quite conclusive as to the question, whether difference of secreted fluids in the animal economy can be ascribed to difference in the structure of, and therefore of the movement of the blood through, the organs in which they appear. "The same organ," he says, *i.e.*, the organ secreting the same fluid from the blood, "presents in different classes of animals, sometimes in the same class, perfectly distinct structures. This is true of the salivary glands, of the testes, even of the liver, of which the organisation is the most uniform, and likewise of the kidneys." "It would be interesting also," he adds, "to compare the secreting organs with their secreted fluids, and observe whether the organs that have a similar structure afford similar products. But experience will sanction no such theory. Nothing, for example, can be more various than the matter furnished by 'crypts' in different animals, from a simple mucus to the most odoriferous compounds." "The simplest secreting organs," he observes elsewhere, "are in insects, where they are merely tubes which float in the general nourishing fluid, which is in contact with their outer surface, while their inner surface contains the secreted fluid. Secretion there can be only a kind of *filtration;* but how different from that which can take place where there is no life, through 'an inorganic solid!'" (*Leçons sur l'Anat. Comp.* Lect. xxx., Art. 1.)

But farther, not only is the complex vascular structure and the varying pressure from contracting solids, which was regarded by MURRAY as the main cause of the formation of new compounds out of the blood, shewn by the examination of other animals, to be quite unnecessary for that purpose; but we now know, that where these conditions exist, that formation is *never* effected—the most compound fluids of the animal economy, which *appear* in the different glands, being really not formed there, but in the course of circulation, and appearing in the blood or in other parts of the body when the organs where they usually appear have been extirpated, or rendered useless by disease; that is, when the cause to which their origin is here ascribed has been absolutely withdrawn.

The mere selection and attraction out of the blood at different places, of different compounds already existing and circulating in it, is certainly the chief, and, according to many, and particularly according to Dr DAUBENY himself, the sole office, performed by any parts *of animals* by which any new organic products are exhibited; and the office of forming those organic compounds, the origin of which is the great chemical change effected by living beings, is performed by no organ capable of exerting a varying power of contraction and pressure, but simply by *the cells of vegetables*, where the fluid introduced from without is usually not conveyed in vessels at all, and is clearly not subjected to any such pressure from contracting solids, as is exerted on the blood in most animals; nor to any such peculiar cause of movement as can be ascribed to the living property of contractility, the only one which Dr DAUBENY admits to be strictly vital.

I have formerly stated, and notwithstanding the opposition of Dr DAUBENY and others, still think, that the judgment of various authors on the respective offices of vegetables and animals as to vital affinities,—the supposition that *no* organic compound can be formed in animals, and that their office is *merely* the selection and appropriation of the compounds formed in vegetables, and afterwards the destructive assimilation by which these are restored, through the excretions, to the inorganic world, is too hasty. It appears from the experiments of

Liebig himself, that the infusory animals decompose the carbonic acid of the air, and exhale oxygen in like manner as vegetables; and the evidence of the formation of oily out of saccharine or amylaceous matters in many animals appears to be unequivocal. The two distinct powers, therefore, of *forming* and of *fixing*, or appropriating the organic compounds, are not so accurately divided between the vegetable and animal world as has been thought. But the more that any physiologist is convinced, as Dr Daubeny is, that the formation of organic compounds is peculiar to vegetables, certainly *the less reason* can he have for supposing that this great change can be due to any mechanical movements, on the principle of contraction and impulse, arising out of the vital principle; the provisions for such movements being so striking a part of the economy of animals, and never having been proved to exist at all in vegetables.

But, *secondly*, In maintaining the scientific correctness of the doctrine of vital affinity, as I have defined it, I think it quite unnecessary to go into these details. I maintain that the objections made to this doctrine, both by Daubeny and Humboldt, are *logically incorrect*, because, in dealing with a set of facts so extraordinary, so important and characteristic as the chemical changes of living beings have been shewn to be, they hold it to be incumbent on us to prove the *negative* proposition, that these *may not* ultimately be referred to those laws which regulate the chemical changes in dead matter, which may be acting under conditions not yet known, and of which they say nothing. The rule of sound logic is,—"*affirmantibus incumbit probatio.*" It is admitted on all hands, that the phenomena of life in general are so peculiar and important as to be properly ranked together as a separate science; and we have shewn that of these phenomena, the most essential and characteristic are certain chemical changes, which are admitted to be so distinct from any that can be observed anywhere else in nature as to "indicate the existence of a power distinct from any simply chemical or physical forces." It is clearly incumbent on those who maintain that, nevertheless, these ordinary chemical forces, acting under conditions not yet understood, may be found adequate to this explanation, to give evidence in the way of observation and experiment of this proposition, otherwise their doctrine is only a hypothesis. If the subject is not thought worthy of scientific inquiry at all, then Physiology is not a separate science. If it is regarded as a separate science, of equal interest and importance as any other, then it is the duty of physiologists, acting on the strict method of induction,—because ascending from facts to principles, instead of descending from principles to facts,—to examine these individual phenomena themselves, arrange and classify them as they present themselves in the different classes of living beings, and consider how far laws deduced from the observation of dead matter can go in the explanation of them; but wherever we find that there is a difficulty in that explanation,—instead of straining the principles of other sciences formerly ascertained, to make them include phenomena admitted to be distinct from any of those to which they have formerly been applied,—it becomes our duty to attempt the investigation and determination of laws peculiar to *this* department of nature. If these laws shall ultimately resolve themselves into any previously known and more general laws of nature, science will be simplified, and a great advance made; but it is assuredly mistaking the right order of inquiry to assert that, *because such simplification may ultimately be effected,* therefore we are now to decline giving these phenomena an appropriate name, and endeavouring to reduce them to general laws by an induction limited to this department of nature itself.

This is the principle which has been successfully followed in other departments of science. Speculations have been hazarded as to the cause of the principle of Gravitation itself. I recollect that the late Mr PLAYFAIR used to say a few words in favour of one of these, the theory of Ultra Mundane Particles continually moving in all directions through all space, although not making themselves known to the human senses; which, if admitted, would resolve the principle of gravitation into that of motion communicated by impulse. But no one will maintain that it was incumbent on NEWTON to prove, that this theory would *not* explain the phenomena, before asserting the principle of gravitation, and determining, by observation and experiment, the laws according to which that principle acts, or by which the phenomena coming under that head are regulated. It is, indeed, observed in many departments of science, that one great difficulty in the early inquiries is, to keep the inquirers from deviating into lines of research which they may think analogous to their own, and applying prematurely principles which have been established by an induction of very different facts. This is the error which Dr REID made an object of special remark when speaking of the "enumeration of the original powers and laws of our mental constitution." "Success in an inquiry of this kind it is not in human nature to command; but perhaps it is possible, by caution and humility, to avoid error or delusion. The labyrinth may be too intricate to be traced through all its windings; but if we stop when we can trace it no farther, and secure the ground we have gained, there is no harm done; a quicker eye may in time trace it further."—(*Hamilton's edition of Reid,* p. 40.) In physiology itself, it is a similarly just and comprehensive observation of Mr LAWRENCE, "that although organised bodies are subjected in many respects to physical laws, yet, as regards their own peculiar phenomena, the reference to gravity, to attraction, to chemical affinity, to electricity or galvanism, can only serve to perpetuate false notions in physiology, and to draw us away from the proper point of view in which the nature of living phenomena, and the properties of living beings, ought to be considered."—(*Two Introductory Lectures,* p. 161.) It was the same idea, not, perhaps, so accurately conceived, but more graphically announced, which prompted Dr WILLIAM HUNTER's remark, in commencing the subject of Digestion in his anatomical lectures. "Some tell you that we have here a fermenting vat, and some tell you we have a stewpan, but I tell you *we have a stomach*." And when we remember how little has been done to elucidate the function of digestion by likening the changes in the stomach either to fermentation or to chemical solution (although both are principles which appear to act to a certain extent), and how much comparative anatomists and physiologists have done, by extending their inquiries into other classes of animals, and studying in all, the changes which commence in the stomach and terminate in the different organs of excretion—to establish laws peculiar to physiology, under which so many forms of structure, and so many vital operations may be arranged,—we can hardly fail to admit that this distinction was wisely drawn. Indeed, the whole science of Morphology, or of the *analogies of the structures* formed by living action—as it is certainly a branch of knowledge strictly *sui generis*—may be said to furnish an illustration of the advantage of keeping the investigation of the laws of living action entirely separate from all other scientific inquiries.

But the authority to which I would wish particularly to refer, as sanctioning and authorising the view of the chemical phenomena of the living body which I here advocate, is that of HALLER, whose great achievement in physiology was simply that of establishing the strictly vital nature, and laying down the most important laws, of the living property of Contractility; the only property concerned in organic life which is expressly admitted by Dr DAUBENY to be truly vital, but to the assertion of which the mechanical physiologists of that age were opposed, on grounds, as it appears to me, exactly analogous to those on which the doctrine of vital affinity is now opposed, because *it had not been proved* how far the mechanical properties of matter were, or were not, adequate to explain the movements of living bodies.

"As all physiology," says HALLER, "involves a history of motions by which the animal machine is agitated, and as all motions have their own laws, we can perceive why, about the end of last century, the principles of hydraulics, hydrostatics, and mechanics, were transferred to physiology. There is a difficulty in this matter, however, and if we reckon up all the good, and all the evil, which has been done to physiology, by the cultivation of these sciences, some may think that we might gladly renounce all the good, for the sake of escaping the evil. There are certainly many things in the animal economy very different from the effects of ordinary mechanical laws; great movements excited by slight causes; the flow of fluids hardly diminished by causes which, according to established mechanical laws, ought to arrest them entirely; motions excited by unperceived causes; vigorous movements produced by the contraction of weak fibres, &c.; from which I do not infer, that simply physical laws are to be repudiated in physiology; but this I maintain, that they are *never to be transferred to the explana-*

*tion of phenomena of living bodies, unless their application is confirmed by experiment.*"—(*Phys. Prin.*, p. 6.)

It might have been perfectly fairly argued at that time, that physiologists did not understand all the conditions, under which the laws of mechanics and of hydraulics (admitted to have a certain influence) act in a living body, and that until it was ascertained that these *would not suffice* for the explanation,—that there was some *residual phenomenon* of life not capable of being so explained,—the exposition of any laws of motion peculiar to living bodies was premature. But HALLER did not think it incumbent on him to prove this *negative* proposition, before announcing the laws of muscular irritability as distinguished from any merely physical cause of motion; and I believe we shall all now admit, that if he had thought this incumbent on him, the greatest impulse which the science of physiology received during the last century, would have been long, and perhaps indefinitely, postponed.

Fortified by these authorities, as well as by some formerly quoted, I again assert, that the only truly scientific view to be taken of this department of Physiology is, that its object is to ascertain, by the method of induction, to use again the expressions of Professor WHEWELL, "when, and in what manner and degree, *chemical* as well as mechanical agencies are modified, overruled, or counteracted in living bodies, by agencies which must be *hyper-chemical* as well as hyper-mechanical;" and I farther maintain, that the term Vital Affinity is as accurate a term as can be employed as a general expression for these agencies; that, like all other general principles in nature, we may expect it to act according to general laws, and that several of these laws, to which I have referred in this and former papers, are already ascertained, at least, in so far as to shew that the subject is one of legitimate inquiry.

I am aware that it may be still said that this dispute is only a verbal one, and can have no practical or even strictly scientific application. But in answer to this I would observe, that so long as we adhere to the supposition, that there is nothing truly vital or peculiar to living bodies in their economy (as regards their organic functions), except motion, and that motion derived from contraction of solids and impulse, the notions that we can form of the nature of these functions in health, and of the deviations from that state in disease, *must necessarily be erroneous*, because we shall always be looking in the wrong direction for the cause of these phenomena; and that at this precise point the most plausible medical theories of the last, and even of the present age, have gone astray. This, I think, is sufficiently illustrated by the example already given, of the ingenuity of Dr MURRAY wasted in the invention and defence of the hypothesis which ascribed the secretions of animals to varying impulse on their fluids from contracting solids; and I shall only add a single illustration of the same kind drawn from the science of Pathology, and from the most fundamental of all inquiries in it, the theory of Inflammation. It being sufficiently obvious, that inflammation is strictly a vital process, and one in which the flow of blood through the affected part is materially changed, it was naturally supposed that the vital powers by which that movement is affected in the natural state, must be those which undergo modification in this diseased state; when, therefore, it was believed that the only truly vital power concerned in the organic functions of the living body is one form or other of contractility, the only explanations of the phenomena of inflammation that were attempted turned on the possible modifications of the contractile *powers of vessels*, as influenced by their contents or through their nerves. But I believe it is now pretty generally admitted, that all this was nearly lost labour; and if physiologists had earlier seen that the most fundamental and characteristic of all strictly vital actions,—those by which nutrition and secretion are effected, and which have always more or less of a chemical character, take place, not in vessels, but in cells, independently of any contractions of the organs containing the fluids—that they are most obvious in those living beings which have neither heart, arteries, nor veins;—and that, as occurring in the higher animals, they are carried on partly in the interior of the fluids contained in the vessels, and partly in the matter that has exuded from the vessels and lies exterior to them,—they would sooner have perceived, that all the changes of action *of the organs* of circulation, heart, arteries, or capillaries, in the case of inflammation, are to be regarded as *effects* of the truly essential, fundamental, and strictly vital changes, which take place *in the fluids* of an inflamed part, and in the *relation between the fluids and solids* there; *i. e.*, in matter which is apparently at rest, and much of which, being outside the vessels of the part, has escaped from all influence of the vital contractions either of heart or vessels.

I do not say that we have a satisfactory explanation of inflammation merely by taking this view of it,—regarding it as fundamentally a perversion of nutrition or secretion, and the circulation as only secondarily affected; but I maintain that in this way we can understand, and so far explain, by reference to more general facts, known in the history of the sound as well as the diseased body, many facts as to it, which we never understand at all so long as we think only of *altered action of vessels*,—but which are easily arranged along with others previously known, when we regard them only as indications of changes in vital actions that are constantly going on *in living fluids*, both those contained in vessels, and those recently delivered from them, into the cellular structure *of living parts*. Thus, we can perceive how inflammation should *spread*, as it does, not along the course of vessels, but *from a point as from a centre*,—not only along *continuous* surfaces, but to *contiguous* surfaces lying beside them, but supplied from other vessels, the larger branches of which frequently undergo little or no change in the process; thus we can perceive how the amount of effusions and exudations from the blood in inflamed parts should bear no fixed proportion to any action of the heart, or of any contractile organ by which it is propelled into those parts,—the most copious effusions sometimes taking place when the impulse of the blood, passing along the larger arteries, is distinctly feebler than natural during the whole disease; thus we can understand how the blood passing through an inflamed part should undergo a change in its own constituents, and how the fluid, which escapes from the vessels there, should possess a peculiar composition, and be peculiarly fitted for certain vital actions, and thereby for repairing some of the injuries resulting from the inflammation itself. Thus, also, we can understand and admit a principle which has been confidently disputed, but which I have long thought, and now find to be maintained, as fairly established, viz., that matter exuding as a result of simple inflammation, may afterwards degenerate, according to the state of the constitution, into various forms of heterologous deposit. (*See e.g. Copland and Quain, in Medico-Chirurgical Transactions,* vol. xxxiii., p. 144.) Still more, if we regard it, as I think we may, as an established fact, that the vital properties of living fluids, as well as solids, are of temporary duration only, and are subject to the general law, of increased action being followed by diminished action, or accelerated loss of vitality, we can understand how the most important consequences of inflammation, both beneficial and injurious, should be produced,—how the matter that was concerned in it being peculiarly excited, and, therefore, quickly rendered *effete*, should be peculiarly liable to Absorption, which we know to be the agent by which its injurious effects are chiefly effaced,—how the increased absorption should, under certain circumstances, extending to the adjoining sound parts, effect that destruction of texture which we call Ulceration; and how, in other circumstances, either of peculiar violence of the inflammation, or depressed vitality of the organ inflamed, this form of diseased action should, by the established laws of vitality, lead to premature death of the diseased part, *i. e.*, either to partial Sloughing or more extensive Gangrene. All these are facts of the highest practical importance, of which we have explanations so far satisfactory, on the strict principles of induction, when we look to the changes that take place in inflamed parts in those living actions which I have referred to the heads of Vital Attractions and Repulsions, and Vital Affinities; but I will venture to say, that we never shall have any explanation of them consistent with the supposition, that the contractions of living solids are the only changes in organic life which are truly vital, *i. e.*, dependent on laws essentially distinct from those that regulate the changes of inorganic matter.